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ANVIK RIVER SALMON ESCAPEMENT STUDIES

1976

(From Yukon River Anadromous Fish Investigations)
Completion Report For July 1, 1974 to June 30, 1977

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ANVIK RIVER SALMON ESCAPEMENT STUDIES

Introduction

A salmon enumeration project was conducted for the fifth consecutive year to obtain indices of the magnitude of king and summer chum salmon escapements in the Anvik River system. The objectives of this project were to: (1) determine the daily and seasonal timing and magnitude of the salmon escapements, (2) evaluate various enumeration methods by comparing aerial survey, boat survey, and tower counts, (3) determine age, sex, and size composition of the king and chum salmon escapements, (4) evaluate different counting tower schedules, (5) measure climatological and hydrological conditions, (6) undertake preliminary on-site evaluation of a Bendix Corporation acoustic side scan salmon counter.

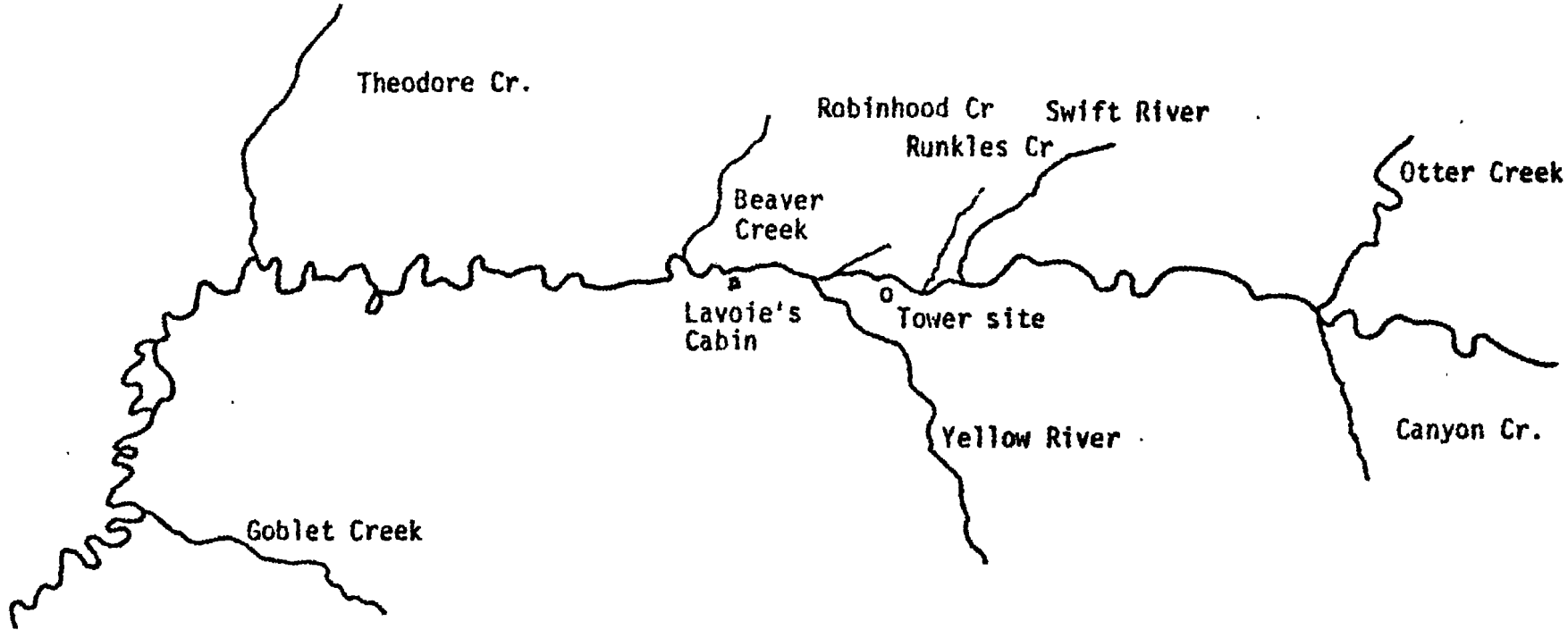
The Anvik River is the single most important chum salmon producer in the Yukon drainage. The Anvik system accounted for 53% of the observed escapement of summer chums in the Yukon's ten most productive streams for the combined years 1974-1976 (Appendix Table 12).

Other species present in this system include king salmon, coho salmon, pink salmon, Arctic char, Arctic grayling, broad whitefish, round whitefish, pike, slimy sculpin, stickleback, blackfish, and Arctic lamprey.

The Anvik River flows in a southeasterly direction from its headwaters for 140 miles to enter the Yukon River 1-1/2 miles north of the village of Anvik (Figures 2 and 6). The upper portion of the drainage is mountainous with elevations generally ranging from 1,000 to 2,500 feet. Toward the River mouth, the terrain decreases to an elevation of about 500 feet. Vegetation along the stream bank includes cottonwood, spruce, willow, tamarack, alder, grasses, and sedges. Throughout most of the length of its main channel the streambed is generally of gravel composition; above Swift River, much of the streambed is bedrock.

The U.S. Fish and Wildlife Service calculated the discharge in 1957 at 5,670 c.f.s. and the velocity at 4.5 ft/sec at a point 6 miles upstream of the mouth. The average depth and the width at this point were 7 feet and 225 feet respectively. Water levels were at flood stages when these measurements were taken during late August -early September. Department personnel in late July of 1975 calculated the discharge to be 2,403 c.f.s. at a point 3-1/2 miles below Theodore Creek. The River was at low stage during this time with an average depth of 2.15 feet, width of 250 feet, and midstream velocity of 4.47 ft/sec. Discharge at the Robinhood Creek Tower Site was estimated at 703 c.f.s. on July 30, 1976. The River width at this point was

Figure 6. Anvik River Map.



217 feet with an average water velocity and depth of 2.68 ft/sec and 1.12 feet, respectively. Longtime residents of the Anvik area stated that water levels during the late summer and early fall of 1976 were the lowest they had ever observed.

The upper Anvik is clear except during periods of high discharge. Clearwater conditions, which permit the visual enumeration of salmon, however, are the exception rather than the rule downstream of the Yellow River mouth.

In 1974 upstream temperatures had reached 51° F by June 16; in 1975 upstream water temperatures of 50° F were not recorded until July 4 (Appendix Table 13). Water temperatures in the mid-fifties were recorded as early as June 13 in 1976. During cold snaps in mid-June and early July, water temperatures dropped into the mid to high 40s.

A PH range of 7.5 to 8.5 was documented at the old tower site in 1974 (Trasky 1975). At the Robinhood Creek Tower Site in 1976, PH readings ranged from 8.5 to 9.

Dissolved oxygen measurements in 1975 ranged from 8.8 pm following the peak of salmon spawning on July 21 to 13.8 on July 6 prior to the beginning of spawning. Levels in 1976 ranged from 10 ppm on June 28 to saturation or slightly above.

Materials and Methods

Materials and methods used in 1976 were similar to those used by Trasky in 1974 (Trasky 1975). Materials for weir construction were transported to the Robinhood Creek site from Anvik village by riverboat and from Bethel by aircraft following ice out in early June (Figure 7). A permanent storage facility for gear and equipment was constructed at the site. Tents for living, mess quarters, and for equipment storage were erected on the west bank of the River immediately downstream from the planned weir site.

By June 24 the water level at the Robinhood Creek location had dropped sufficiently for weir construction to begin. The weir was essentially completed on June 27 following 3 days of installation. The entire width of the river was weired with the exception of a forty foot center section (Plate 1) where the maximum flow rate and water depth were located. Boats could pass up and downstream through the weir opening. The counting tower consisted of a 22-foot high prefabricated aluminum structure erected on a log raft anchored just upstream of the weir opening. The raft was composed of six large logs and was of similar design to those used to float fish wheels.

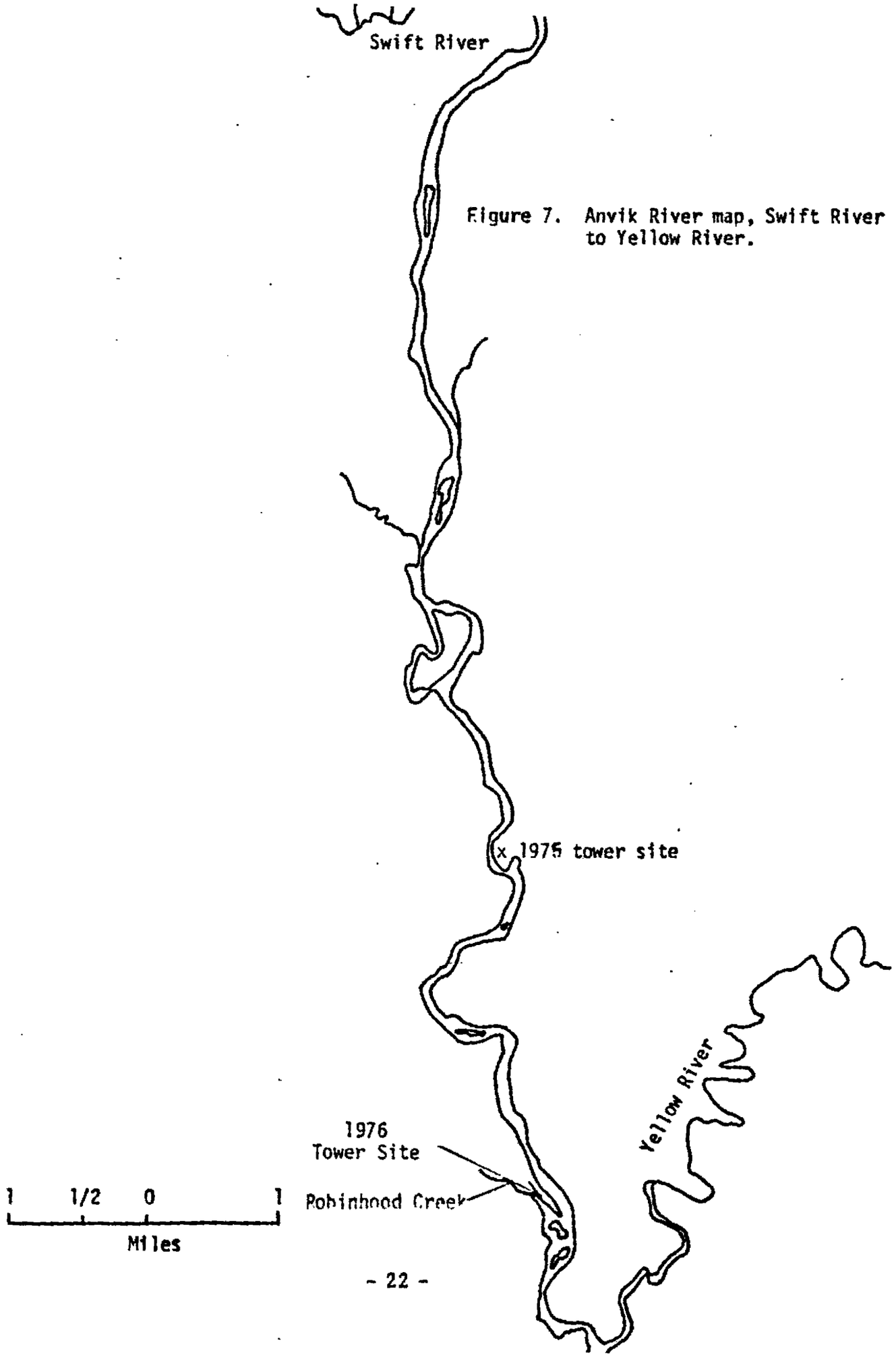
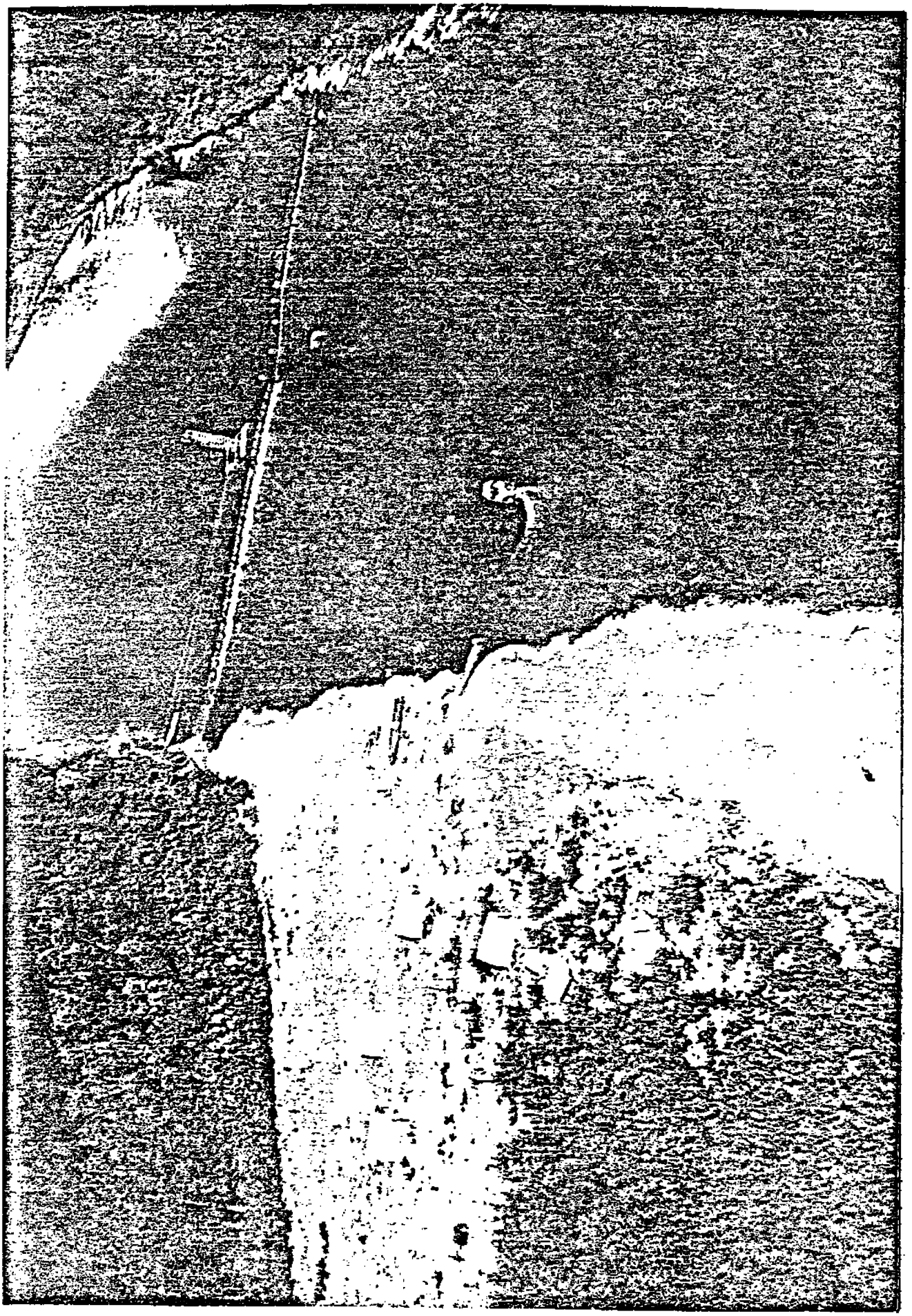


Figure 7. Anvik River map, Swift River to Yellow River.

Plate 1. Anvik River counting tower Robinhood Creek site.



A power line, incorporating four 300 watt light bulbs housed in 18-inch diameter reflectors, was strung across the open channel to provide illumination during darkness. A 1500 watt generator provided electric current for the lights.

Fish visibility was enhanced by a background panel (40 foot x 3 foot) of white herculite upholster cloth laid across the stream channel between channel ends of the weir. The panel was attached to a cable running across the bottom and weighted down with sandbags and steel beams.

Daily counts were begun on June 27, 1976. Char and grayling were also enumerated to gain information concerning the numbers of non-salmon fish species passing the weir site.

Char and grayling enumeration was continued until the appearance of the first chum salmon on June 30. After this date, counts were essentially limited to salmon. Weir counts terminated on July 28 when net upstream chum and king salmon migration was virtually zero. Counting shifts were normally of 2 hours duration at the maximum.

Salmon swimming downstream were subtracted from the upstream migrants to obtain a "net upstream count". Incomplete daily counts for chum and king salmon were estimated by computing the percentage (P) of total count made during the missing hours (s) for all other days over the entire season. This percentage was subtracted from 100% (1-P) and divided into the daily count (A) to produce an expanded daily total (E) or:

$$\frac{A}{1-P} = E$$

Hourly counts were calculated by taking the same percentage (P) of the expanded daily total and substituting it for the missing hourly counts. No conversion factor had been developed for pink salmon until the 1976 season. Hence, in 1974 and 1975 actual daily counts were expanded in direct proportion to the percent of the hours not counted to give an expanded total. (See Appendix Table 14 for illustration of the above and other calculations used in this report).

The size of king salmon passing the tower was estimated by comparison with the background panel. The size classifications were 500 mm (trout size), 501-600 mm (chum size), 601-800 mm (average king), and 801 mm (large king). These estimates were made to attempt the estimation of the size and age composition of the king salmon escapement.

Chum salmon carcass sampling and enumeration surveys were conducted from boats upstream and downstream of the tower site from July 22 to

July 27. A scale smear was taken from each fish examined, length (mideye to fork of tail) measured, and sex of each carcass recorded. King salmon carcass surveys were made of the main Anvik River above LaVoie's cabin from August 1 through 12. Data collected was the same as for chum salmon.

Aerial surveys of the Anvik were conducted on July 16 and July 21 to enumerate king and chum spawners and carcasses and to determine distribution within the River system. An aerial survey was conducted to enumerate king and chum salmon in the Yellow River on July 20. Aerial surveys were conducted on September 18 and 21 to enumerate coho salmon in major Anvik tributaries.

Drift surveys were made by boat to enumerate spawning king salmon on July 27 and 28. Surveys included the main River between the 1975 tower site and Beaver Creek (Figure 7).

Tissue samples were taken from approximately 100 chum salmon at the Anvik weir for electrophoretic analysis by the Fisheries Research Institute, University of Washington. The object of the analysis was to determine whether sufficient differences in poroteins exist to identify and separate discrete spawning stocks such as those of the Anvik River from other Yukon stocks. Results of the analysis will be presented in a later report.

A beach seine was used during July to locate and capture king, coho and chum juveniles for age/growth data. This was the second season of juvenile salmon collections in the Anvik River.

Climatological information was recorded daily. Stream flows and limnological data were taken periodically.

The Anvik Tower Site was moved in June of 1976 after counting difficulties were experienced due to water depth and to high water conditions continually experienced at the site used during 1974 and 1975. Stream reconnaissance surveys in the late summer and fall of 1975 had identified a suitable weir site immediately upstream from the mouth of Robinhood Creek (approximately 1 mile above the mouth of Yellow River). The River at this point, during most summer flows, ranges from 215 to 250 feet across with a maximum depth of 2 to 2.5 feet.

Because of the improved weir arrangement made possible by the move to the Robinhood Creek site, the 1976 Anvik tower count was probably the most accurate to date. Low, clear water conditions and the uniform light color of the streambed enhanced the accuracy of the 1976 counts.

Five personnel were needed to adequately operate both the tower and an experimental sonar counting installation in 1976. Three persons were used

in 1974 and 1975. During the early years, only the counting tower was in operation. Additional persons available for counting duties probably reduced the error that may have resulted when long counting periods were required of these individuals. The acoustic side scan salmon counter, developed by the Bendix Corporation and field tested at the Anvik site during 1976, was capable of counting non-salmon species at certain sensitivity settings. On the other hand, downstream salmon migrants, or those moving randomly downstream past the transducer were counted as if they have moved upstream or not at all. The counter is non-directional. Correction factors are being developed using tower information which will apply to the sonar counts. Mass downstream movement of salmon was observed on July 3 and 4, 1976 during an electrical storm.

Although costly, 24 hour tower counts were made for most of the 1976 season. Counts during the 1974 and 1975 seasons were confined to the hours in which the greatest percentage of the chum migration had been documented in 1973, i.e., 2400 to 0700 and 1300 to 2400 hours. Eighty-one percent of the chum and 73% of the king salmon daily migration past the tower in 1973 occurred during these time periods. Studies by Hurd (1970) indicated that the daily migration patterns for chum salmon in Norton Sound did not change significantly from year to year. Because of the tower site change and the lack of base data on which to construct expanded counts, Mauney (1976) recommended a 24-hour count schedule be run for at least one additional field season.

Partial hour counting schedules may be considered to reduce the number of man hours required during future seasons. Ten minute counts at the beginning of each hour were evaluated in 1974 by Trasky (1976). It was found that chum and king salmon expanded counts gave results that were 8 and 16% above the actual count, respectively, for the entire season. Fifteen minute counts were evaluated in 1976.

Results

Analysis of the 24-hour counts obtained in 1973 and 1976 showed that 19% of chum and 30% of king salmon movement occurred between 0700 and 1300 hours (Appendix Tables 15-19). The 6 hour period of least movement of chum salmon was from 0500-1000 (16.5%) and for kings from 2300 to 0500 (10%). The best "compromise" time period to omit counts would appear to be from 0300 to 0800 when only 19.7% of the chums and 20.4% of the kings were counted. The low period of pink salmon migration appeared to be between the hours of 0800 and 2200 when 15.2% of the movement occurred during 1973 and 1976 observations (Appendix Tables 20 and 21). The expansion factor used for chum in 1974 and 1975 was 1.19 and 1.27 for king.

In 1976, 15-minute counts were recorded at the beginning of each hour. The expanded daily chum salmon count for the season was 105% of the actual count (Appendix Table 22). Thus, the partial hour enumeration and expansion technique would appear quite satisfactory for chum salmon.

Chum salmon downstream movement is expressed as a percentage of upstream movement for Anvik field seasons 1972 through 1976 in Table 3. The percentage has fluctuated from a low of 3.4 in 1972 to a high of 19.5 in 1976 for a yearly average of 11.4. King salmon downstream movement has averaged 19.6% of upstream movement for the 3 years for which such data is available. Additional base data is needed to arrive at a factor for downstream movement that could be incorporated with confidence into side scanner count correction.

Table 3. Anvik River chum and king salmon movement upstream versus downstream compared for years 1973-1976.

Year	Number upstream	Number downstream	Net upstream	Downstream movement expressed as % of upstream
		Chum Salmon		
1972	65,202	2,239	62963	3.4
1973	76,904	6,483	70421	8.4
1974	149,753	14,629	135124	9.8
1975 1/	284,830	24,511	260319	8.6
1976	229,077	43,866	185211	19.5
Total	805,766	91,728	714038	11.4
		King Salmon		
1973	539	112	427	20.8
1974	338	30	308	8.9
1976	908	208	700	22.9
Total	1,785	350	1435	19.6

1/ Movement data available through 7/14 only for 1975. Movement data for actual counts.

Arctic Char and Arctic Grayling. A combined total of 1,499 char and grayling was counted past the Robinhood Creek tower site from June 27 through July 1, 1976 (Table 4). Char and grayling could not reliably be distinguished from each other from the counting tower height of 25 feet under varying light conditions. Three thousand six hundred and forty seven of these two species were counted (expanded count) over the 5 days of observation. Preliminary observations of the side scanner adjusted for salmon counting indicated that only exceptionally large individuals of these species were counted.

Table 4. Char and grayling counts past the Anvik Tower, 6/27-7/1, 1976. 1/

Date	Number Upstream	Number Downstream	Net Upstream	Downstream % Upstream	No. Hours	Expanded Daily Total
6/27	420	28	392	7.1	10	941
6/28	278	22	256	8.6	8	768
6/29	183	7	176	4.0	8	528
6/30	178	14	164	8.5	8	534
7/1	583	72	511	14.1	14	876
Total	1,642	143	1,499	9.5	48	3,647

1/ After July 1 only salmon were counted; char and grayling could not be reliably distinguished from each other from the counting tower.

Summer Chum Salmon

Timing: The first chum in 1976 was observed at the new tower site on June 30. In 1975, chum salmon were not observed in the vicinity of the tower until July 5 with counts beginning July 6 (Figure 8). Lateness of the 1975 chum run is believed to have been a function of extremely low, early summer, water temperatures as discussed earlier. Chum migration past the tower showed a normal pattern in 1976 until July 3 and 4 when water temperatures fell. Upstream movement picked up very rapidly starting July 5. On July 7 the peak daily count for the season of 46,156 was recorded. To date only 1974 has shown an earlier peak count for chum. The 98% level of the run was reached on July 20 (Appendix Table 23). Only in 1975 during an exceptionally large run, were chum still moving upstream in substantial numbers by this date.

Hourly migration patterns for the same 18-hour period during 1973, 1974, 1975, and 1976 are shown for chum salmon in Figure 9. Some variations in hourly migration patterns can be noted. Migration patterns in 1976, as in earlier years, indicated generally reduced movement between 0700 and 1300 hours. Least movement for chum salmon occurred between 0500 and 1100 A.M.

Abundance: The expanded Anvik tower count of 237,831 summer chums was the second highest count since the project was initiated in 1972, but was only 39.5% of the record 1975 count of 601,880 (Table 5). The 1974 count of 201,280 approached the 1976 count. The 1976 count is the most

Figure 8. Comparison of daily migration patterns for chum salmon, Anvik River, 1973-1976

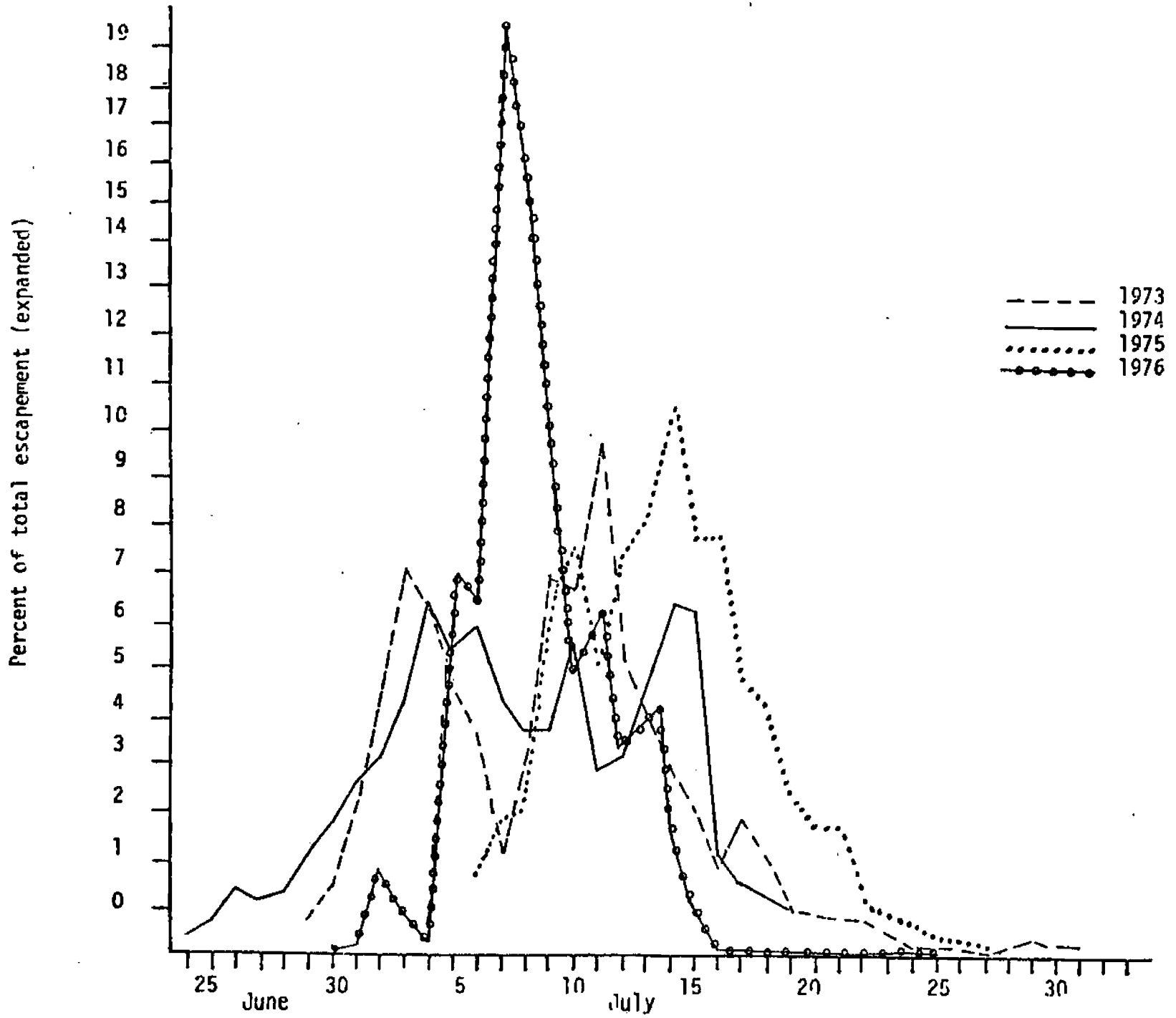
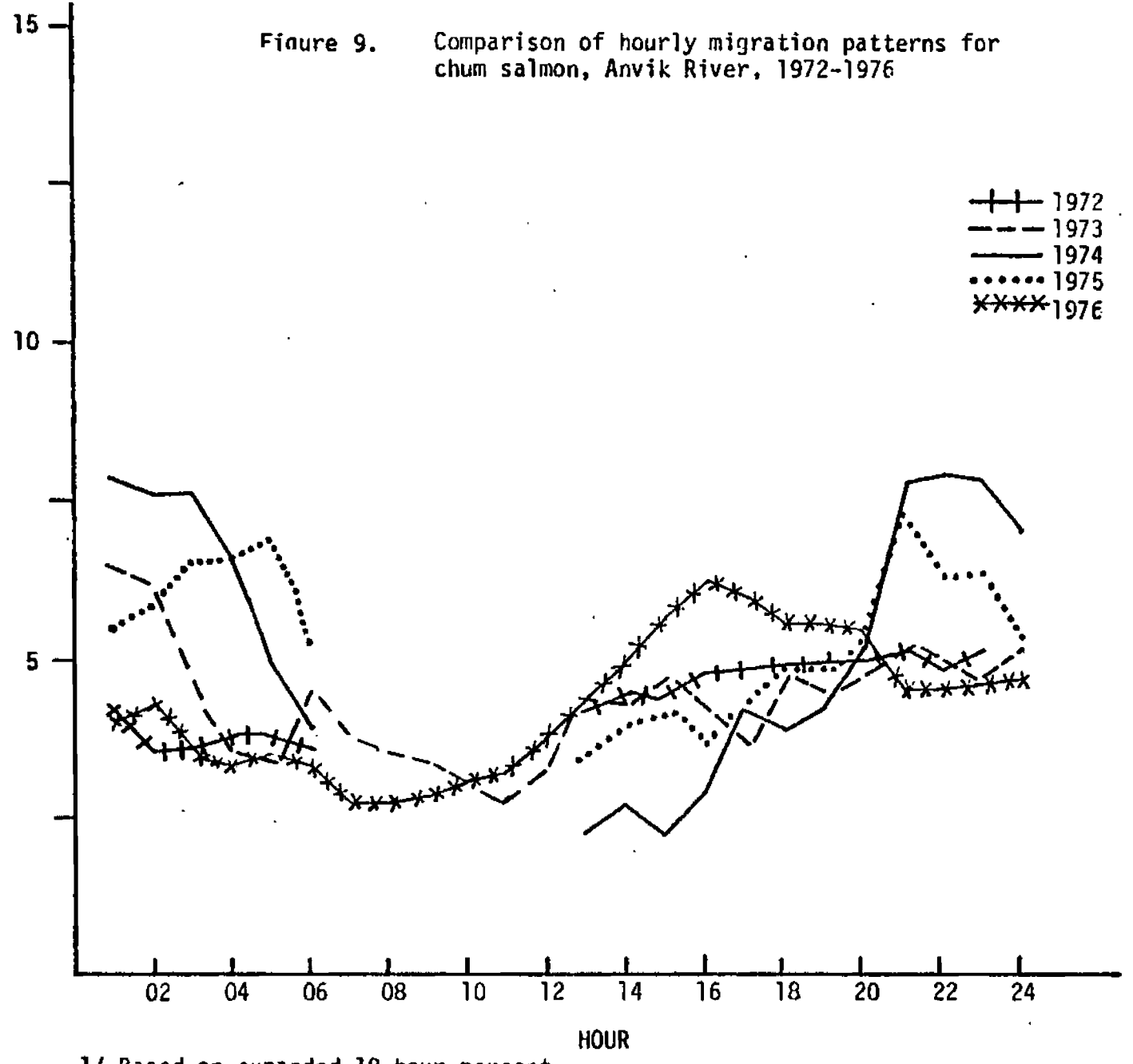


Figure 9. Comparison of hourly migration patterns for chum salmon, Anvik River, 1972-1976



1/ Based on expanded 18 hour percent.

accurate count conducted on the Anvik River to date due to the improved weir and tower arrangement and to low, clear water conditions which existed throughout the 1976 season giving ideal counting conditions.

Table 5. Historical estimates of Anvik River king and chum salmon escapements, 1958-1976 1/ 5/

Year	Chum Salmon Tower	Aerial	King Salmon Tower	Aerial
1976	237.85	382.49 2/	958 4/	195 2/ 3/
1975	601.88	845.24	548	845
1974	201.28	-	471	-
1973	71.48	26.16	517	222
1972	108.34	208.76	1,104	414
1971	-	-	-	-
	-	232.76	-	368
1969	-	-	-	296
1968	-	51.58	-	297
1967	-	116.00	-	336
1966	-	37.00	-	638
1965	-	100.00	-	650
1964	-	13.00	-	-
1963	-	-	-	-
1962	-	-	-	-
1961	-	20.60	-	1,226
1960	-	-	-	1,950
1959	-	200.00	-	350
1958	-	150.00	-	-
Total	1,220.83	2,383.59	3,598	1,676

$\bar{X}$		Chum	King
Tower:	5 years	244.11	719.6
Aerial:	13 years	183.35	335.2

1/ Chum salmon in thousands of fish
2/ Aerial count in 1976 includes Yellow River
3/ Poor survey
4/ Count from new tower site
5/ Tower counts expanded to estimate numbers during non counted periods.

The best estimate of numbers of chum salmon in the Anvik system during 1976 is 406,166 (Table 6). This total includes a Yellow River aerial count of 38,680. This was the first year water conditions in the Yellow River made a count of this River practical, but even then water visibility was judged only fair to poor. The Yellow River estimate may represent only 30 to 40% of the chum salmon present with actual numbers approaching 100,000 in this tributary.

Table 6. Summary of Anvik River peak salmon escapement counts, 1976.

	King	Chum	Pink	Coho	Total
Tower (expanded)	958	237,851	519	-	239,328
Anvik below tower (aerial) 1/ 2/	1	129,635	-	81 3/	119,772
Yellow River (Aerial)	93	38,680	-	-	38,773
Boat survey below tower (kings only)	103	-	-	-	103
Total	1,155 4/	406,221 4/	519	81	397,976

1/ Aerial surveys of lower Anvik and Yellow Rivers generally rated as 50-60% effective for chum salmon. High counts used in totals. No attempt was made to separately count pink salmon.

2/ Includes Beaver Creek and Anvik-Yellow River to Robinhood Creek surveys of 7-16 and lower Anvik survey of 7-21. Tower count was 98% complete by 7-21. No attempt was made to determine numbers of kings during 7-21 survey.

3/ Coho documented, Beaver Creek only, during surveys 9-18 and 9-21.

4/ Aerial counts above tower: king-100
chum-267,845.

The escapement figure of 812,998 chum salmon (weir and aerial count) into the Anvik in 1975 [tower count upstream plus aerial count downstream (with fair to poor water conditions in the lower river and the Yellow River not surveyed)] was regarded as a minimal figure. It is probable that more than 1 million summer chums spawned in the Anvik system during 1975. The actual chum salmon escapement into the Anvik in 1976 probably approached 500,000.

Distribution: Anvik River spawning distribution of chum salmon for 1975 and 1976 is presented in Table 7. Spawner distribution within the system was much the same for 1975 and 1976. A somewhat greater percentage of spawning may have occurred in tributary streams in 1976 than in 1975 (examples: Beaver Creek 2.3% and 5.7% for 1975 and 1976 respectively; Swift River 2.6% and 8.7% for 1975 and 1976 respectively). The relative number of spawners above and below the Anvik tower changes from year to year and has ranged from a high of 77.1% above the tower in 1975 to a low of 34.1% above in 1972 (Table 8). Sixty-one point three percent of the salmon escapement observed in 1976 during aerial surveys was above the Robinhood Creek tower site. Comparisons of spawner distribution should take into account the fact that the Yellow River was surveyed in 1976 for the first time and included with the downstream escapement. This may compensate for the inclusion of escapement between the old and new tower sites for the first time in the upstream category. The 4 year upstream average escapement has been 66.1% of total escapement. Distribution of spawners in 1976, therefore, appears to be average.

The aerial survey estimate of 267,845 chums made on July 21 was higher than the weir count of 231,657 by 15.6%.

Carcass surveys were conducted by foot along major sandbars. Relative carcass density from area to area and from year to year may be used as an index to relative abundance. Four-thousand yards of beach were surveyed from the area of Beaver Creek to the area of Swift River in 1975. The carcass density was 4.07 chum salmon per linear yard (July 25-August 1). Two thousand yards were surveyed in this stretch of River in 1976 (July 25-27). The chum carcass count per linear yard was 1.60 (Appendix Table 24). Beach surveys of the lower 4 miles of Yellow River in 1976 revealed a much lower average density of 0.29 chum/linear yard in 1976.

Age, Sex, Size Composition: Anvik River chums in 1976 were predominantly (85.5%) 5_1 fish (1971 brood year). Age class 4_1, which accounted for 92.6% of chum examined in 1975 comprised only 13% of the 1976 sample (Table 9). This age composition shows the outstanding success of the 1971 brood year.

Appendix Table 25 shows that in 1976, as in 1975, Anvik male chums were significantly longer than Anvik female chum, (599 versus 560 mm). Anvik chum sampled in 1976 were also significantly longer than Anvik chum sampled in 1973, 1974, and in 1975 (respectively, 577, 552, 565 and 553 mm). This greater average length of 1976 Anvik chum is believed to be a function of the unusually large percentage of 5 year old fish present in the 1976 run (Table 9).

Table 7. Anvik River observed king and chum salmon escapement distributions as indicated by aerial survey 1975 and 1976 1/.

Stream Location	Chum				King			
	1975		1976		1975 2/		1976 2/	
	No.	%	No.	%	No.	%	No.	%
Below Goblet Creek	6,800	0.8	2,875	0.6	-	-	0	0.0
Goblet-Beaver	59,425	7.0	48,555	11.1	4/	-	1	0.5
Beaver Creek	19,005	2.3	25,700	5.7	1	0.4	0	0.0
Beaver-Yellow River	50,900	6.0	24,475	5.6	3	1.4	1	0.5
Yellow River	3/	-	38,680	8.8	3/	-	93	47.7
Subtotal lower River	136,130	16.1	140,285	32.0	4	1.8	95	48.7
Yellow River-Robinhood Creek	4/	-	25,200	5.8	4/	-	0	0.0
Robinhood Creek	3/	-	2,830	0.6	3/	-	0	0.0
Robinhood Creek-Old Tower Site	4/	-	24,150	5.6	4/	-	14	7.2
Yellow River-75 Tower	75,000	8.9	4/	-	24	10.8	4/	-
75 Tower-Runkles Creek	4/	-	18,700	4.3	4/	-	1	0.5
Runkles Creek-Swift River	4/	-	29,000	6.6	4/	-	26	13.3
Swift River	21,545	2.6	38,335	8.7	3	1.4	2	1.0
Swift River-Otter Creek	4/	-	56,375	12.9	4/	-	25	12.8
75 Tower-Otter Creek	345,200	40.9	4/	-	120	55.0	4/	-
Otter Creek	47,645	5.6	47,585	10.9	1		2	1.0
Canyon Creek	3/	-	3,855	0.9	3/	-	0	0.0
Otter Creek-McDonald Creek	215,250	25.5	47,375	10.9	70	31.5	30	15.4
McDonald Creek	2,470	0.3	4,465	1.0	0	0.0	0	0.0
Above McDonald	250	-	5/	-	0	0.0	0	0.0
Total River	843,490	100.0	438,155	100.0	222	100.0	195	100.0

1/ Aerial surveys: 1976 dates, 7-16, 7-20, 7-21, 7-21; 1975 date, 7-23.
2/ Counts not representative of actual numbers of king salmon in system.
3/ Not surveyed.
4/ Survey not broken down in this manner.
5/ Fewer than 200 chum.

Table 7. Anvik River observed king and chum salmon escapement distributions as indicated by aerial survey 1975 and 1976 1/.

Stream Location	Chum				King			
	1975		1976		1975 2/		1976 2/	
	No.	%	No.	%	No.	%	No.	%
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aver Creek	19,005	2.3	25,700	5.7	1	0.4	0	0.0
aver-Yellow River	50,900	6.0	24,475	5.6	3	1.4	1	0.5
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total lower River	136,130	16.1	140,285	32.0	4	1.8	95	48.7
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River- Creek	4/	-	56,375	12.9	4/	-	25	12.8
wer- Creek	345,200	40.9	4/	-	120	55.0	4/	-
Creek	47,645	5.6	47,585	10.9	1		2	1.0
Creek	3/	-	3,855	0.9	3/	-	0	0.0
Creek- ld Creek	215,250	25.5	47,375	10.9	70	31.5	30	15.4
ld Creek	2,470	0.3	4,465	1.0	0	0.0	0	0.0
McDonald	250	-	5/	-	0	0.0	0	0.0
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ears %
4.1
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Sex composition of 3,762 chum salmon carcasses was determined during beach surveys in 1976, resulting in a male/female ratio of 36/61. Thirteen thousand four hundred and thirty nine carcasses were sexed during 1975 beach surveys with a resulting male/female ratio of 49.8/50.2, statistically an insignificant difference. Age and sex composition data for the years 1972-1976 is presented in Table 10. Samples were gathered by carcass survey and by weir capture. The resulting male to female ratio of 46.8/53.2 indicated a slight bias favoring females. The cause of the skewed 1976 sex ratio of carcasses has not been determined at this time.

Table 10. Age and sex composition of chums sampled by post-spawning crew surveys, and at Robinhood Creek weir, 1972-1976. 1/

Age	Male No.	%	Female No.	%	Total No.	Total
3_1	5	0.8	4	0.7	9	1.5
4_1	43	7.2	35	5.8	78	13.0
5_1	233	38.8	281	46.8	514	85.5
6_1	0		0	0	0	
Total	281	46.8	320	53.2	601	100

1/ Percent of total sample.

1977 chum salmon returns to the Anvik will probably be fewer than those of the last 3 years. The 4_1 age class is usually dominant for the Anvik, and in the 1973 parent year, only 71,480 passed the tower. The 1972 5_1 year class was dominant for the Anvik in 1976. The 1972 tower escapement which would give rise to the 1977 5_1 return was 108,340. The Anvik return in 1977 should be in the neighborhood of 100,000 chums, based on these figures and assuming average freshwater and marine survival.

King Salmon

Timing: The 1976 season's first king salmon was observed at the Robinhood Creek Counting Tower on July 5. A peak count of 107 indi-

viduals was obtained on July 17 (Table 11 and Figure 10). Ninety-five percent of the run had passed the tower by midnight of July 24 (Appendix Table 26). Net daily upstream counts were fewer than 20 king salmon by July 26.

King salmon migration timing shown in Figure 10 during 1976 was generally intermediate between that of a very late year (1975) and an early year (1974). The 95% level was not reached until July 28 in 1975, 1 day prior to termination of counting. On this date 43 kings were counted past the tower. A substantial portion of the king run may have occurred after the termination of counting activities in 1975. King salmon movement past the Anvik tower in 1974 began early (6-24) and had peaked by July 15. High water took out the weir on July 19 of 1974, terminated counting, and left the last stages of the run undocumented. The spawning run was somewhat more protracted in 1973 than in 1975.

Hourly upstream migration patterns for the standard 18 hour count period are shown in Figure 11 for the years 1972 through 1976. This measurement of movement is expressed as the percent of total seasonal migration to pass the counting tower in a given hour of the day. Migration peaked at 1500 hours in 1976. Two peaks, at 0500 and 1400 hours, occurred in 1975. The highest counts in 1972 and 1974 occurred between the hours of 1300 and 1700. Based on 24 hour counts conducted in 1973 and 1976 (combined data) the lowest continuous 6 hour period of king salmon movement is from 2300-0400.

Abundance: The 1976 Anvik tower expanded count of 958 kings was the second highest since the record count of 1,104 in 1972, the year the project was initiated (Table 5).

The best escapement estimate of Anvik system kings in 1975 combines the upper River weir, lower River float, and Beaver Creek aerial survey estimates for a total of 730 (Mauney 1976). The king escapement estimate for this system in 1976 was 1,155 (Table 6). The 1976 estimate also includes 93 kings seen in the Yellow River which was not surveyed in 1975.

The 1975 count is probably low, due to the lateness of the run, with substantial numbers of fish moving past the tower when operations were terminated, and also due to frequently poor counting conditions. The 1974 count of 471 is also judged low by approximately 40 fish, due to high water conditions which forced early project termination on July 19 (Trasky 1975).

Despite poor survey conditions, the Yellow River aerial count of 93 kings on July 26, 1976 was close to that of the Anvik above Robinhood Creek on July 21 (100 fish) which had good survey conditions. The king salmon

Table 11. Daily net upstream salmon counts (expanded), Anvik River Tower (1976).

Date	King		Pink		Chum	
	Number	%	Number	%	Number	%
6-30					2	0.0
7-1					932	0.4
7-2					4,219	1.8
7-3					1,806	0.8
7-4					603	0.3
7-5	3	0.3	5	1.0	18,504	7.8
7-6	7	0.7	5	1.0	17,365	7.3
7-7	12	1.3	22	4.3	46,156	19.4
7-8	29	3.0	13	2.5	37,580	15.8
7-9	30	3.1	18	3.5	24,569	10.3
7-10	34	3.5	33	6.4	14,386	6.0
7-11	44	4.6	35	6.7	17,046	7.2
7-12	58	6.1	23	4.4	10,468	4.4
7-13	85	8.9	100	19.2	12,370	5.2
7-14	41	4.3	39	7.5	6,147	2.6
7-15	60	6.2	22	4.3	3,805	1.6
7-16	77	8.0	28	5.3	4,533	1.9
7-17	107	11.2	44	8.5	3,879	1.6
7-18	68	7.1	18	3.5	2,866	1.2
7-19	39	4.1	16	3.1	2,518	1.1
7-20	29	3.0	33	6.4	1,904	0.8
7-21	15	1.6	12	2.3	1,391	0.6
7-22	67	7.0	23	4.4	1,290	0.5
7-23	46	4.8	11	2.1	1,354	0.6
7-24	42	4.4	3	0.6	857	0.4
7-25	27	2.8	4	0.8	413	0.2
7-26	18	1.9	9	1.7	345	0.1
7-27	18	1.9	3	0.6	279	0.1
7-28	2	0.2			264	0.1
Total	958	100	519	100	237,851	100

Figure 10. Comparison of daily migration patterns for king salmon, Anvik River, 1973-1976

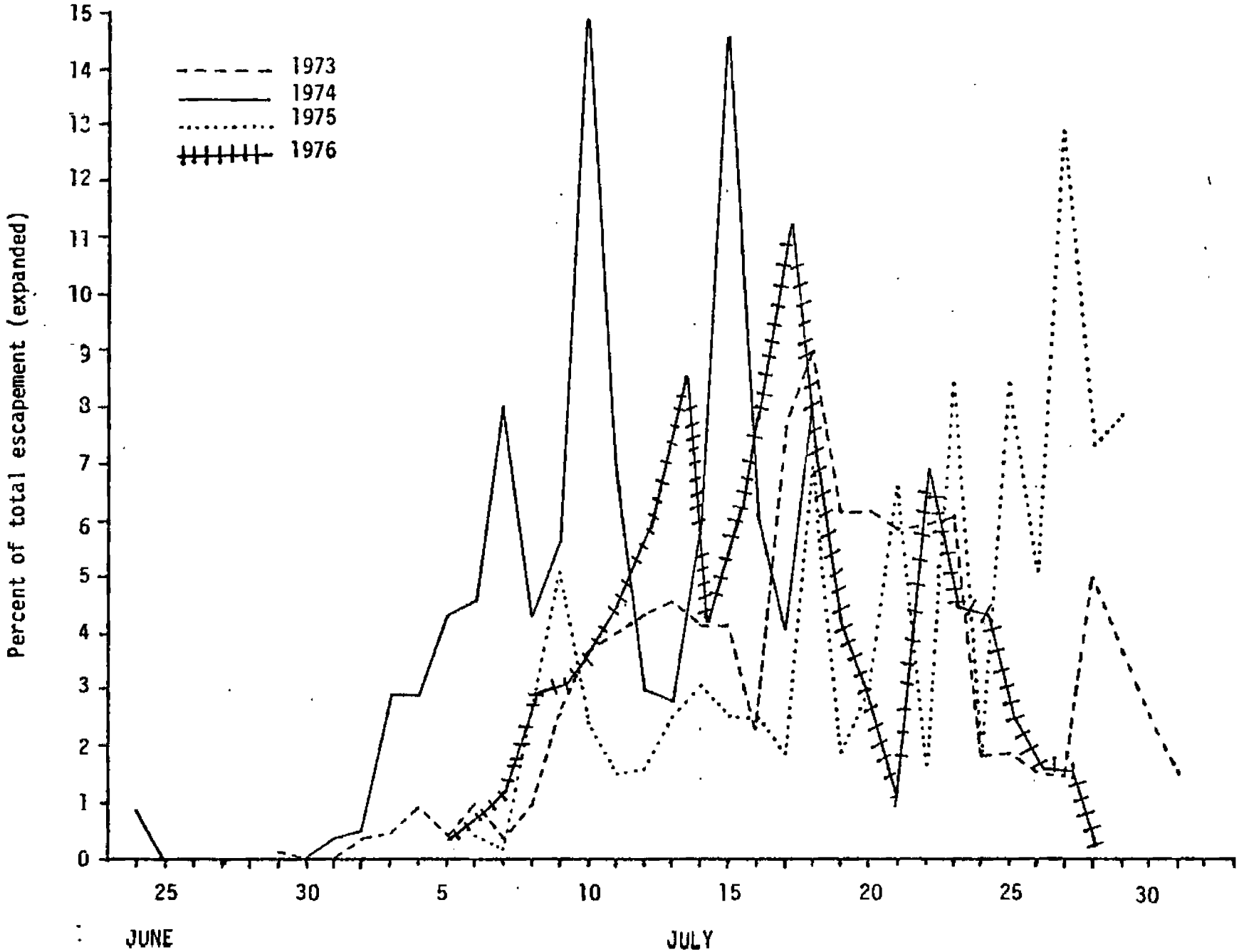
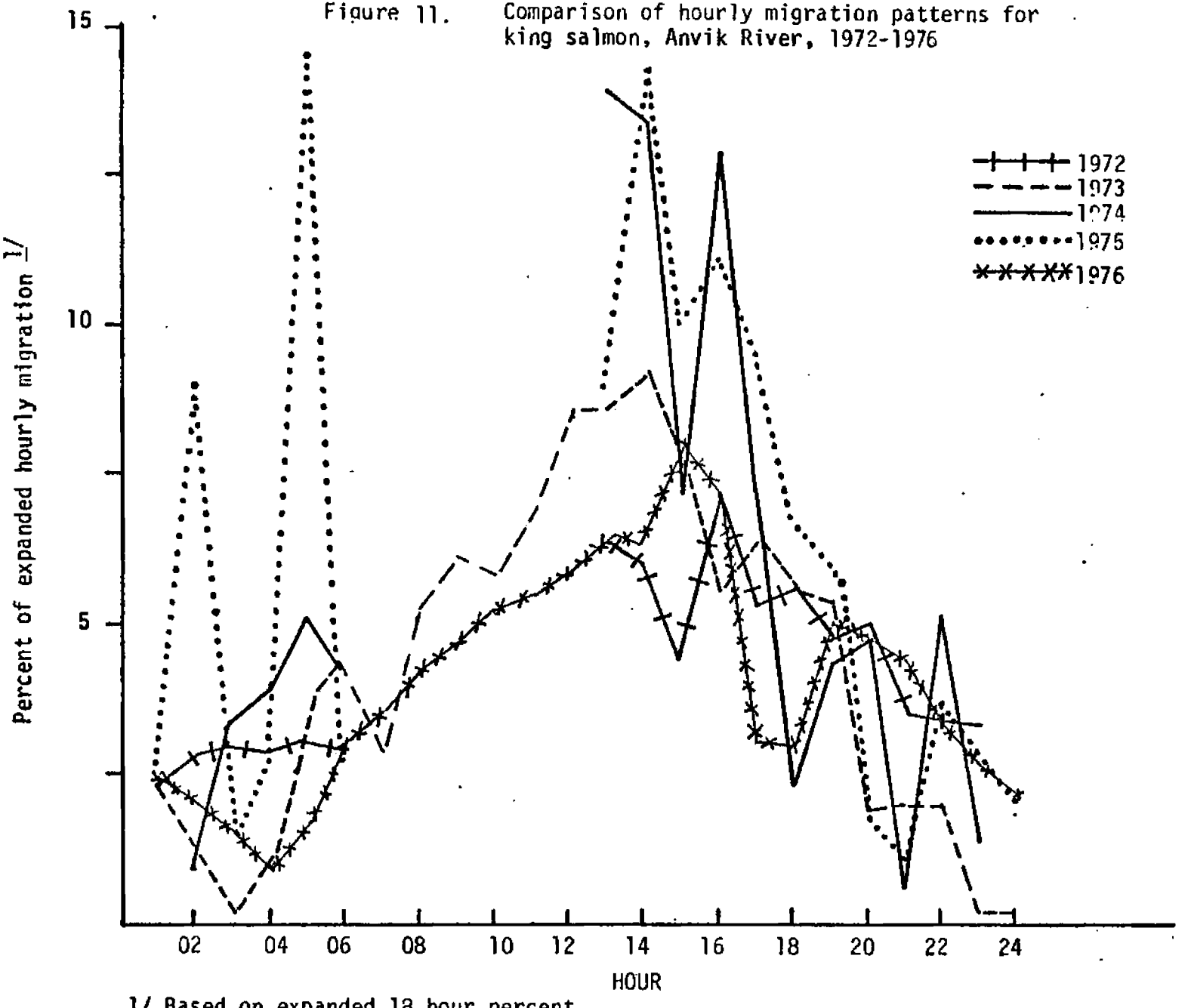


Figure 11. Comparison of hourly migration patterns for king salmon, Anvik River, 1972-1976



1/ Based on expanded 18 hour percent.

escapement past the tower site was 723 by this date. Greater numbers of chum salmon in the main Anvik may reduce the accuracy of king salmon counts. The impression was that kings were as abundant in the Yellow River as in the Upper Anvik. If the effectiveness of the aerial survey on the Yellow was similar to that on the main Anvik, where roughly one salmon was observed out of seven known to be in the escapement, then the Yellow River king escapement would have been nearly 700 by July 21 when the Anvik tower escapement was 77% complete. Using these assumptions as a basis, the total Anvik River drainage system king spawning escapement probably approached 2,000 fish in 1976.

Distribution: One hundred twenty three kings were counted during a boat survey on July 28 from the old tower site to the new tower site, a distance of about 3 miles. King salmon migration past the Robinhood Creek site had virtually ceased by this date. Hence, it is likely that most of the salmon between the tower sites were spawning.

Most king salmon spawning within the main Anvik and tributaries (with the exception of Yellow River) occurs upstream of the Robinhood Creek Tower Site (Table 7). Relatively few king salmon have been observed in the major upstream tributaries.

Age, Sex, Size Composition: Since 1972, few king salmon carcasses of the Anvik River run had been sampled for age, sex, and size composition until the 1976 field season, mostly because carcasses are not readily available until the first week in August.

Additional king salmon age-weight-length (AWL) data is needed for the following reasons: (1) Sex, length and age data for the Yukon are currently collected largely from commercial catches and are probably biased because of the selective nature of the fishery. Size and age selectivity by fishwheels and gillnets has been demonstrated statistically. (2) The only major king salmon stream in the Yukon drainage that is currently adequately sampled is the Salcha River. A carcass sampling crew remained on the Anvik into mid-August to collect king salmon data in 1976.

Forty-five king carcasses were examined for age and sex in 1976; 73% were male and 26% were female. The predominant age represented was 5_2 (67% of kings sampled); age 6_2 and 4_2 fish comprised 20 and 13% of fish sampled respectively (Table 12).

Table 12. Sex and age composition of 1976 Anvik River king salmon scale samples. 1/2/

Age	Male No.	Male %	Female No.	Female %	Total No.	Total %
4_2	6	13.3	0	0	6	13.3
5_2	25	50.0	5	8.9	30	66.7
6_2	2	4.4	7	15.6	9	20.0
Total	33	73.3	12	26.7	45	100.0

1/ Dates of collection August 11 and 12.
2/ Percent of total sample.

Based on total length estimates made from the tower, the dominant size category in 1975 was 601-800 mm (35% of those estimated). Abundance by size category was similar in 1974 (Table 13), while the larger size category of over 800 mm was predominant in 1973. The size categories of 501-600 mm and 601-800 mm were equally represented in the 1976 sample.

Table 13. Estimated size of king salmon migrating upstream past the Anvik River tower, 1973 through 1976.

	Estimated Size 1/									
	Under 500 mm		501-600 mm		601-800 mm		800mm		Total	
Year	No.	%	No.	%	No.	%	No.	%	No.	%
1973	19	4.1	46	9.7	112	23.6	297	62.6	474	100
1974	5	1.4	123	34.4	150	41.9	80	22.3	358	100
1975 2/	16	7.1	59	26.1	80	35.4	71	31.4	226	100
1976 2/	3	12.0	359	39.0	336	37.0	105	12.0	911	100
Carcasses										
1976 3/	1	2.0	8	16.0	33	66.0	8	16.0	50	100

1/ Total length.
2/ Does not include salmon seen but not clearly discernible.
3/ Lengths mideye to fork of tail.

The average male carcass measured in 1976 was 665 mm (38 fish); for 13 females the average length was 794 mm (Appendix Table 25). Both averages are within the 601-800 mm range into which 37% of the tower observations fall. By comparison, Emmonak commercial catch samples of 1,050 kings taken with 8-1/2 inch gillnets in 1976 averaged 825 mm. However, it is recognized that gillnets of this mesh size are selective for large fish. It is probable that a larger carcass sample size is needed from the Anvik to provide an accurate estimate of actual population age and size. Usual estimates of size by tower observers may have been at variance from the actual.

Based on the record high count of king salmon observed for the 1972 brood year of 1,104 fish, it is anticipated that the king salmon returns of 5 year old fish to the Anvik in 1977 could be at a high level with an escapement of 1,000 or more. The king salmon harvest in the Yukon was also at a relatively high level in 1972. An incompletely assessed, but apparently significant factor in king salmon returns, is the impact of the Japanese high seas fishery on survival of immatures. Low king catch per unit of effort by the Japanese fleet in 1975 may indicate poor returns to the Yukon in 1977.

Pink Salmon. An expanded total of 493 pink salmon was counted past the Anvik tower during 1976 (Appendix Table 20). A record high of 1,366 pink salmon was counted in 1975. Pink salmon tower counts for 1973 and 1974 were 286 and 197, respectively. The Anvik River apparently is close to the upstream spawning limit for this species in the Yukon River system and sustains only a marginal population. During years of large chum escapements as in 1974, 1975, and 1976, pink salmon are probably obscured by the much greater numbers of chum salmon present and counts are likely much lower than actual numbers. No pink salmon were observed during either 1976 aerial or beach surveys.

Coho Salmon. Aerial surveys were attempted of the Anvik River and its major tributaries on September 18 and 21 of 1976 to enumerate coho salmon escapement. The weather during this time period was generally overcast with poor light conditions. Eighty-one coho were observed, all in Beaver Creek. On September 22, 1975, 467 spawning coho were observed largely within Beaver Creek and Swift River. A high percentage of the coho salmon observed were still bright and silvery in appearance at the time of the survey. The surveys may have been conducted too early to accurately assess coho abundance. In general, coho salmon abundance in the Yukon River for 1976 as indicated by escapements observed in the Tanana River system appeared to be reduced from past levels.

Juvenile Salmon. Experimental beach seine operations were begun in late July of 1975 and revealed the presence of juvenile king and coho salmon in riffle and pool areas near the tower site and Lavoie's cabin (Figure 6). Eighteen juveniles were captured on September 24 in the area of Robinhood Creek. Eleven of these juveniles were examined; six were king salmon (age 0, total length range 64-74 mm), and 5 were coho salmon (age 0, total length range 53-97 mm).

Beach seining was continued and expanded in 1976. In addition to king and coho, numbers of chum salmon juveniles were also taken in the Anvik 1976 collections (Table 14). It is the opinion of the collector that juvenile chums, not initially recognized in collections, were present in very large numbers at the Robinhood Creek and Runkles Creek areas. Collections in the latter area were made as late as July 14. Chum salmon juveniles had not been documented in the Anvik during past summer seasons. The fact that their presence was observed in 1976 may in some way to be a function of the extremely large escapement in 1975.

With an earlier capture date in 1976, king juveniles were generally of a smaller size than those taken in the September 1975 collection. A single Age 1 coho was found in 1976 collections.

Table 14. Length analysis by species of juvenile salmon taken by seine, Anvik River - July, 1976. 1/

Species	Date	n	$\bar{x}$	S^2	Range	Age
King	6-26	7	36.3	6.24	34-41	0
King	7-14	51	52.5	13.10	44-60	0
King	7-15	1	56			0
Coho	7-15	1	92	-	-	1
Chum	6-26	21	44.1	22.75	31-55	0
Chum	7-14	15	46.4	28-26	38-57	0

1/ King and chum samples for 6-26 taken from Robinhood Creek; king and chum collected on 7-14 from Old Tower Site to Runkles Creek; king and coho samples for 7-15 from Lavoie's cabin sites.

Acoustic Side Scan Salmon Counter. Bendix Electrodynamics Division has been developing acoustic salmon and smolt counters since 1964. The utilization of such counters can result in considerable savings in manpower, relieving staff of the often expensive, monotonous, and tedious work of counting fish. The utilization of sonar counting can make possible the counting of fish under conditions of turbid and/or deep water and poor light conditions at locations where counting would be visually impossible.

Total Anvik River salmon escapement can only be ascertained by the establishment of a counting system in the lower River well below the Yellow River and other important lower River spawning areas. Due to the predominantly turbid water conditions in the Yellow River and other lower River tributaries, clear water conditions which would permit the visual enumeration of salmon in the lower Anvik are rare. The Bendix acoustic salmon counter, if successful, will greatly improve salmon enumeration capabilities in the Anvik.

A suitable site for the establishment of a side scanner installation and for visual comparative counts was located in the lower Anvik in 1975. Bendix redesigned existing acoustic fish enumeration systems resulting in a "side looking" acoustic salmon counter utilizing a single transducer. This system became available for field testing during the 1976 field season. The Bendix Corporation acoustic side salmon counter is described in detail by Menin (1976).

Initial tests of the side scanner were to be held in areas of clear water, where salmon movement is fairly uniform. The Anvik River Robinhood Creek site was ideal for this purpose. The side scanner had not been employed to count chum salmon prior to the Anvik test. Design of this unit assumes that the salmon migrate just above the streambed at a relatively uniform rate.

Al Menin of the Bendix Corporation brought the side scanner to the Anvik site on July 1, 1976. After calibration, some satisfactory test counts were made (Table 15). Over one 5.4 hour test period 99% correlation was achieved between acoustic and visual counts for chum salmon.

The water in the counting channel was approximately 2 feet deep, very clear, and flowing at 3.2 ft/sec. Chum salmon tended to avoid the the artificial counting substratum utilized in 1976. King salmon passed in very low numbers during the test period, but based on limited observations the side scanner will probably not enumerate kings reliably, particularly when set up to enumerate chums. Counting error due to grayling and char during the Anvik 1976 test was minimal.

Table 15. Side scanner versus visual chum salmon count, Anvik tower July 5 and 6, 1976.

	Visual Count	Electronic Count	Duration	Observer	% Accuracy
	1183	1197	1.5 hours	R. Bain	99%
	500	490	0.5 hours	R. Bain	98%
	659	675	1 hour	T. Namtvedt	98%
	504	436	0.5 hours	T. Namtvedt	87%
	332	337	1 hour	J. Mauney	99%
	772	758	0.9 hours	J. Mauney	99%
Total	3950	3893	5.4 hours		99%

Summary

During the 1976 field season, the Anvik River counting tower operation was moved from the 1975 site. The 1976 tower site was at the mouth of Robinhood Creek approximately 3 miles below the 1975 site. The new site, a shallow riffle area, proved to be ideal for weir installation and counting tower operation. Water conditions throughout the 1976 field season were extremely low and generally very clear.

The first chum salmon observed passing the Robinhood Creek tower site in 1976 was on July 1. The 98% level of the run past the tower was reached on July 20. Only in 1975, an extremely late, cold water year, were chum observed to still be moving upstream in substantial numbers by this date.

Based on the analysis of 1973 and 1976, 24 hour counts, the time of least movement for chum salmon is between 0500 and 1100 A.M.

The expanded Anvik tower count of 237,831 summer chums was the second highest count since the project was initiated in 1972. The 1974 count of 201,280 approached the 1976 count; and the 1976 count was only 40% of the record 1975 count. The total observed count, including the Yellow River, for chums during 1976 was 406,166 fish. It is likely that the actual total chum escapement into the Anvik in 1976 approached 500,000. The total observed count in 1975 was 812,998 with actual escapement believed to be in the neighborhood of 1,000,000 chum salmon.

In 1976, 61% of the chum escapement observed during aerial surveys was above Robinhood Creek. For the years 1972, 1973, 1975, and 1976

combined an average of 66.1% of total escapement observed has been in the upper River.

Carcass sampling of chums in 1976 indicated a preponderance of females to males; 61 to 39% respectively. No difference was found in 1975 in relative abundance of males and females. Age class 4_1 chums dominated escapements from 1973 through 1975. Age class 4_1 chums comprised only 13% of the samples and age class 5_1 from the strong 1971 brood year comprised 86% of samples in 1976.

Anvik River chums sampled in 1976 were significantly longer than those sampled in 1973, 1974, and in 1975 averaging respectively: 577, 552, 565, and 553 (lengths in mm, mid-eye to fork of tail).

The first king salmon observed at the counting tower was on July 5 in 1976. The 95% level of the migration was reached on July 24. Timing of the 1976 runs was normal.

Based on 24 hour counts conducted in 1973 and 1976 the lowest continuous 6 hour period of king salmon movement is from 2300-0400 (10.0% of migration observed).

The 1976 Anvik River tower expanded count of 958 king salmon was the second highest since the high count of 1,104 in 1972. The total Anvik River count in 1976, including the Yellow River was 1,155 fish. Most observed king salmon spawning occurs within the main Anvik River above the Robinhood Creek and within the Yellow River.

A total of 45 king salmon carcasses were examined in 1976; 73% were male and 27% were female. The predominant age class represented was 5_2.

An expanded total of 483 pink salmon was counted past the Anvik tower in 1976. A record high of 1,366 pinks were counted in 1975.

Recommendations

Visual counts should be continued on a 24 hour basis through the 1977 season to provide cross checks between side scanner and visual counts on the following: (1) chum avoidance of the scanner artificial substratum, (2) detection of downstream chum movement by scanner, (3) enumeration of char and grayling by scanner, (4) enumeration of king salmon by scanner.

Continued 24 hour counts will better define the expansion factors needed if shorter periods of visual observation are used along with side scanner counts at a downstream site.

Based on the analysis of 24 hour counts conducted during 1973 and 1976 it has been found that the best compromise 18 hour daily counting period for king and chum salmon is 2400 to 0300 and 0900 through 2400. Background information indicates that 20.4% of the kings and 19.7% of the chums would not have been counted during the six hour non-counting period. The low 6 hour continuous period for chum salmon was from 0500-1100 with only 17% of the total count. The period of least king salmon movement was from 2300 through 0500 which included only 10% of observed movement. During late July, as the chum run terminates, counts should be made during the period of maximum king passage.

A side scanner will be operated at the Robinhood Creek site throughout the 1977 field season. Visual counts will be continued on a 24 hour schedule to check the reliability of the unit. The side scanner will be moved to the lower Anvik site during the 1978 field season if successful at the Robinhood Creek site in 1977. Enumeration of the total Anvik River chum salmon escapement will be the goal at the lower River site.

Aerial survey counts for kings within the Anvik system continue to be very low compared to weir or float counts. Aerial king counts in this system can be regarded as index counts only and not as a measure of actual abundance.

The fair aerial survey made of the Yellow River in 1976 showed it to be a major contributor to total Anvik chum and king production. During most summers, this River will not be surveyable by air; but a survey should be attempted in 1977. Aerial surveys need to be continued downstream of the Robinhood Creek tower in 1977 to determine lower Anvik River escapement levels.

A weir counting tower system should be established in 1978 at the lower River site. The weir will essentially control fish movement for counting by side scanner. As conditions permit, visual observations of chum salmon should continue on a 12 to 18 hour a day basis to give correlation with scanner counts. King salmon counts will probably be possible by visual method only. The Robinhood Creek tower operation should be continued in 1978 to give a check on lower river counting success. The upriver operation will be at a reduced level of 18 hours a day.

Sampling effort for juvenile salmon should be increased. Chum salmon smolt abundance and downstream migration timing should be especially noted.